

# Management of Toxic Packaging Waste Related to Environmental Protection in Iasi and Neamt Counties

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*The aim of the present study was to estimate and compare the toxic packaging waste generation in two urban areas of Iasi (A) and Piatra Neamt (B) counties, in a close relationship with the management of removal and processing. Piatra Neamt was chosen because it is known to have a developed infrastructure for selective sorting and collection of municipal solid waste since 2001, implemented using European funds. On the other part, the center of Iasi city was chosen because the selective sorting of municipal solid waste was really implemented only in this area. There exist no significant differences between the generated total waste amounts in A and B studied areas. The same time, no significant differences between the generated packaging waste average quantities in A and B areas were found. The clear result of this study is that the generated packaging waste represents 32.62% as average when compared to generated total waste in area A and 37.15% in area B. When comparing the fractions of generated total waste in the two areas of study the results are really surprisingly. Since it is well known that Piatra Neamt developed the first integrated system of selective collection of household waste, totally functional starting with 2001. When we are comparing the fractions of generated total waste, the results are not significantly different in the two areas. For sure, there are higher rates for selective collection and sorting of paper/cardboard, plastics, glass and organic waste in area B, but not really significant. Such results could be explained solely by the existence of a similar degree of education and commitment regarding the environmental protection in both studied areas. Moreover, we tried to have an estimation of the management effort of local authorities to remove the generated total waste or its selective fractions from the two studied areas. This was a very difficult challenge. For the moment, our conclusions are that for both cities the management efforts are almost the same, despite the selective sorting and collection of some fractions of generated total waste in area B (Piatra Neamt). The simple conclusion could be that the management efforts of removal are lower in Iasi city starting from the efficiency of the processes.*

*Keywords: environment, packaging waste, costs, solid municipal waste, social responsibility*

Waste generating trends represent an important forecasting goal for local authorities from the point of view of allotment resources and management. Modeling could support the management decisional processes, starting from predictive and forecast analysis. Such analysis necessitates the taken into account of some general indicators as the inhabitants' number, ages structure, specific lifetime expectancy for the region, as well as the generated total municipal solid waste. Thus, it might be possible to predict also the fractions of future generated solid waste. There exist several tools, including Waste Prognostic Tool, to be applied when considering the future generated solid waste for a specific region (urban, rural or mix one). Furthermore, fractions as such as plastics, papers, biodegradables, metals, glasses, and others, could be forecasted using the above mentioned tools. As an example, for Iasi county, the trend model represented by S-curve is the most accurate to forecast the generated municipal solid waste [1].

Actual and future solid waste generation necessitate an appropriate management due to the increased influence on environment, mandatory investments and operating costs. There is no doubt that increased solid waste

generation represents a real problem for local authorities to focus on. Furthermore, there are always attempts to establish the most suitable management scenario from the point of view of costs and efficiency. Some performed analysis for Iasi county considered that the most viable economic scenario would include as treatment methods the sorting, composting and landfilling of generated municipal solid waste [2].

One of the consumer fields producing an increased amount of waste and deeply harming the environment each year is the electronics one. One of the ways that can be addressed for the reduction of environment pollution refer to sustainable design strategies. Firstly, the raw or recycled used materials must be in agreement with the absolute requirements of environment protection established and future rules. The obvious and irreversible trend imply the usage of recycled and remanufactured materials and supplies. Secondly, also as a very important goal, the consumer electronics must include easy to disassemble elements to include almost entirely recyclable components. Not lastly, the labeling must include easy to understand graphic information concerning the use and safety removal of nonfunctional or damaged consumer

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electronics. Furthermore, there are expected innovative and cute design developments being able to motivate and educate users concerning the compulsory environment protection [3].

Another very important aspect related to solid waste generation is involving the packaging of every type of sales. The biodegradable approach represents an actual hot trend from the point of view of research and testing. This trend is justified by nowadays huge amounts of generated non-biodegradable packaging. The packaging waste induces an important burden on environmental protection management. Is there the introduction of eco-tax an efficient way to reduce the effects of generated non-biodegradable packaging on the environment and to change the behaviour of the consumers? There exist efficient measures to reduce the generation of non-biodegradable packaging waste all over the world? The decrease of human negative impact on environment must be continuously a general pursuit of all real leaders. We diplomatically but firmly must force the humanity to respect the environment. All of us are morally and legally responsible for environmental protection, including also the field of retail packaging. Such a task determines the quality of our life as well as of future generations [4].

Increased focus is directed toward the food waste and food packaging waste generation. A clue motivation for the increased generation of food waste and food packaging waste could be the refuse of imperfect products from both vendors and consumers. There is only empirical data on this subject. Although there is no alteration of inner quality or safety of food products, the consumers are facing concerns on validity or packing date, damaged packages or looking. A number of market studies, involving population from the northern European areas, showed that the consumer choices on sub-optimal food products are really dependent on several variables, which might not be constant. Such variables are including the discounting offers, time of choice, mood, age, nationality, personal values, level of education, perceived value and/or importance of food and food packaging waste, as well as several others. Such studies on food market are revealing the preferences of consumers related to imperfect food products and could suggest some rules for the behavior of supply-chains and vendors on sub-optimality of such products [5].

The aim of the present study was to estimate and compare the toxic packaging waste generation in two urban areas of Iasi and Piatra Neamt counties, in a close relationship with the management of removal and processing.

### Experimental part

As mentioned above, the experimental research was developed in two urban and very similar areas of the center of Iasi (area A) and Piatra Neamt (area B) counties. Piatra Neamt was chosen since it is known to have a developed infrastructure for selective sorting and collection of municipal solid waste since 2001, made using huge European funds. On the other part, the center of Iasi city was chosen since the selective sorting and collection of municipal solid waste was really implemented only in this area.

The experimental plan was developed starting from a previous verified one [6,7,8]. The two studied areas included almost an equal number of households, 139 for area A and 152 for area B. We didn't count exactly the number of persons living inside the two areas, but we think that there are not significant differences. The inhabitants from both

areas are medium-income persons. The measurements were applied for 12 weeks the same day of the week and the same months, specific for each area, a little bit before the removal of the waste by the workers of the local authorized institution. The total analyzed quantity of generated waste was 12.26 tons for area A and, respectively, 11.99 tons for area B. The methods used for analysis and team members were all the time the same regardless the area under study.

The indicators we used for our analysis were as follows: total generated waste (kg/household/ week); generated packaging waste (kg/household/week); generated packaging waste and total generated waste ratio. These indicators were further completed with a large estimation of the fractions of waste in two areas, including the paper and cardboard, glass, metals, plastics, wood, organic waste, green waste, textiles and others. Finally, we tried to closely estimate the costs necessary for the removal of the specific and general generated waste in the two analyzed areas.

The experimental plan was completed with the use of Calc module from free Apache OpenOffice in association with Student T-test and Mann Whitney Rank Sum test, to verify if there eventually exist statistical differences. The values of  $p < 0.05$  were considered to reflect such statistical significant differences.

### Results and discussions

The total generated waste (average amount as kg/household/week) for the 12 weeks of study in each of A and B areas are shown in figure 1.

When considering the data in figure 1, there exist no significant differences between the generated total waste amounts in A and B studied areas. This lack of differences might be very interesting since we are speaking about two different cities from Moldova region. The lack of significant differences could be explained by almost the same level of income for the residents of the two areas. That means an almost identical lifestyle for the studied areas.

The average generated toxic packaging waste from both areas included in the study are showed in figure 2.

As figure 2 presents, there exists also no significant difference between the generated packaging waste average quantities in A and B areas. Although there exists a slight difference between the two areas. Interestingly, although the average amount of generated total waste is higher in area A, the average quantity of generated package waste is higher in area B.

Figure 3 is showing the ratio of generated packaging waste and generated total waste, comparatively, in the two compared areas.

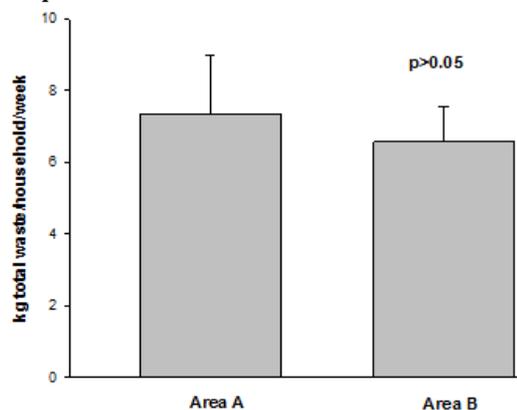


Fig. 1. Amount (kg) of total generated waste in Iasi (A) and Piatra Neamt (B) areas per household and week. Values of  $p < 0.05$  were considered statistically significant

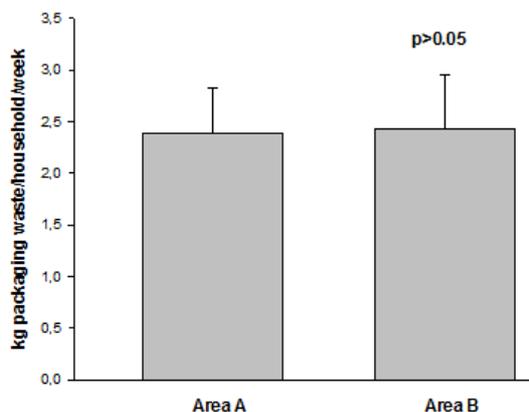


Fig. 2. Generated packaging waste (kg) in area A and area B as average amount per household and week. Values of  $p < 0.05$  were considered statistically significant

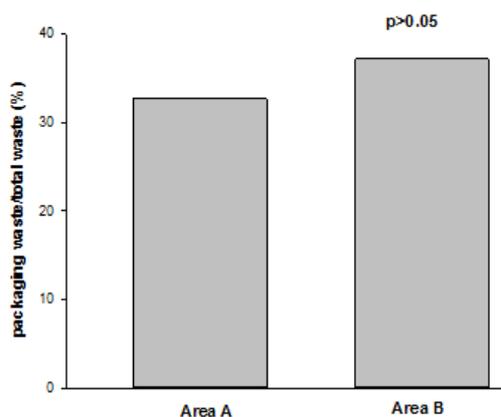


Fig. 3. Generated packaging waste and total waste ratio in the two areas. Values of  $p < 0.05$  were considered statistically significant

The clear result of this study is that the generated packaging waste represents 32.62% as average when compared to generated total waste in area A. Furthermore, for the area B, the generated packaging waste represents 37.15% as average when compared to generated total waste.

Figures 4 and 5 present an estimation of the fractions of generated total waste in A and B areas.

When comparing the fractions of generated total waste in the two areas of study the results are really surprisingly. Since it is well known that Piatra Neamt developed the first integrated system of selective collection of household waste, totally functional starting with 2001. That means there exist separate euro-bins for paper and cardboard,

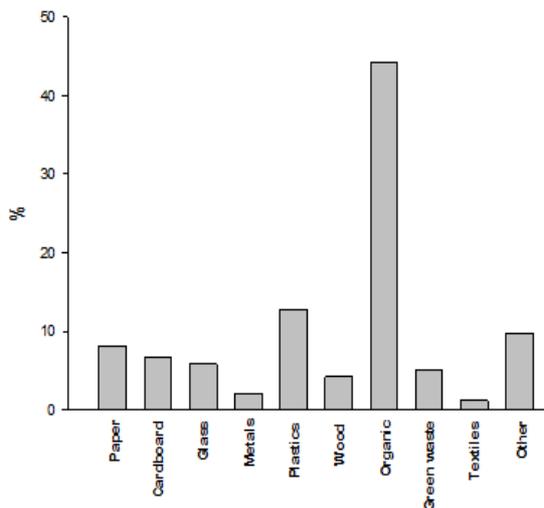


Fig. 4. Average fractions of generated total waste in Iasi area A for 12 weeks of study

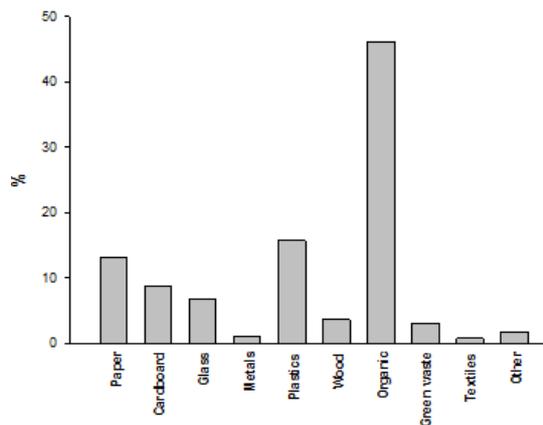


Fig. 5. Fractions of generated total waste (as average) in Piatra Neamt area B for 12 weeks of experiment

plastics, glass, organic waste and residual waste. On the other hand, in Iasi studied area (extended on a small area in the center of the city), there exist euro-bins selectively for paper/cardboard and plastics. When we are comparing the fractions of generated total waste, the results are not significantly different in the two areas. For sure, there are higher rates for selective collection and sorting of paper/cardboard, plastics, glass and organic waste in area B, but not really significant. Such results could be explained solely by the existence of a similar degree of education and commitment regarding the environmental protection in both studied areas.

Moreover, we tried to have an estimation of the management efforts of local authorities to remove the generated total waste or its selective fractions from the two studied areas. This was a very difficult challenge. For the moment, our conclusions are that for both cities the management efforts are almost the same, despite the selective sorting and collection of some fractions of generated total waste in area B (Piatra Neamt). We have no correct idea if the sorted fractions are useful and/or exploited any way by the authorities in Piatra Neamt. The simple conclusion could be that the management efforts of removal are lower in Iasi city starting from the efficiency of the processes.

A really important approach considering the reduction of environment aggression is represented by the return to natural, related to the production of bright and attractive colored plastics. Several studies tried to extract pigments from wasted vegetal materials, i.e. aged leaves of *Vitis vinifera* L. The results are encouraging ones, such pigments could be used for coloring textiles and paintings. Despite this progressive work, the development of accurate methodologies and technologies is needed [9].

With really few exceptions, in Romania the absolute majority of waste collection is including the mixed one, the source sorting being minor accomplished. The recovery of waste involves reduced percentages and only certain categories as packaging waste. The landfilling of municipal solid waste is the main procedure for its removal (more than 95%), incineration being just *curious* method. The reduction of waste generation is in almost no way incentivized. Eco-Rom Ambalaje (ERA, Green Dot Company for Romania) is managing the direct recycling of packaging waste by the actors of industry and vendors (93%). But the costs of recycling are continuously increasing and the compensation transfer of finances from industry isn't enough. That's why the fundamentals of the Extended Producer Responsibility (EPR) imposed by European Commission is far away to be reached. It's the responsibility of local authorities to construct programs focused on the

education of residents to protect the environment. The goals and targets imposed by the Directives of European Union for Romania concerning the packaging waste are difficult to be fulfilled in the next future [10].

The biodegradation of waste (and, specifically, packaging waste) is considered a future approach of major importance for the environment. Microorganism attacks support its basis. There are several attempts to produce biodegradable packaging starting i.e. from polyolefins and lignocelluloses. The microorganism strains involved by such experiments were represented by *Aspergillus*, *Penicillium* and *Fusarium*. The obtained results pointed out the lack of rapid biodegradation when recycled materials were used. The relatively increased oxidative reactivity in the chains of polymers matrices and the FTIR corresponding bands for microorganism proteins and polysaccharides demonstrated on the other hand a slow biodegradation. This slow biodegradation was dependent on the features of used polymers. *Aspergillus* strains were the most effective in the biodegradative processes involving polyolefins and lignocelluloses polymers used to produce packaging [11].

There are also other studies involving the biodegradation by microorganisms as an efficient tool for the bioremediation, involving *Saccharomyces cerevisiae*. These microorganism strains might be useful in the biodegradation and removal of nitrophenols, taking into account the very low cost of the production of yeast suspensions and their availability. Germination wheat tests demonstrated the efficiency of such microorganism strains in decreasing the toxicity of nitrophenol toxicity [12].

Dinitrophenolic compounds are important components of pesticides. Pesticides, beside insecticides, fossil-based fuels, soils with enhanced productivity, completed with irrigation approaches, represents one of the basic bricks of modern agriculture. The risk for long-term uses of such methodologies is environment pollution. The animals and human health are altered, and the agrobiodiversity, ecological and/or social, is deeply affected [13].

The crops, 120 different local and old varieties, provide around 90% of nowadays food production. The extinction of local species involves consequences larger more important than their physical disappearance. The increased genetic erosion is the obvious result of the industrialization of agriculture and unwise using of chemicals as nitrophenols from pesticides [14].

The adequate management of municipal solid waste represents a challenge all over the world, being most important in urban residential areas, the grown number of residents and the increasing of income inducing pressures. Municipal solid waste is a continuous and increasing threatening for the quality of environment and health of humans, animals and plants. Many integrative techniques and methodologies were developed having as goal the analysis of the management of municipal solid waste, trying to measure the sustainability of applied or developing systems. One of such very important applied techniques is Life Cycle Assessment (LCA), which allows the evaluation of scenarios for the future management of municipal solid waste as well as the impact on environment [15].

Environmental protection necessitates inventory planning systems, developed in fine details and with high responsibility. There are some considered secondary issues of the inventory as piece of a larger system, as such as packaging, waste and location. The influence of each of these issues on the whole system and their inter-relationships with the environment are very important. Packaging is really important from several points of view,

including its costs, provided safeguarded conditions, but also could affect the environment through the needed resources to be produced and landfilling potential. Also the waste, the result of a mismanagement, might affect the environment. Location is also a sensible issue since will influence the transportation costs [16].

The development of a friendly management system bent on inter-relationships with the environment is a continuous concern of the leadership of S.C. AVI-TOP S.A. Razboieni-Iasi, for example. This environmental management system must be in accordance with European rules and with local tendencies. There might be developed a balance between economic interests and environmental protection needs, the clear final goal being pollution expelling [17].

Resilience becomes an important concept in many fields, although it has not a clear and generally accepted definition. The local environment characteristics are able to control one firm resilience in certain conditions [18].

Biodegradable packaging materials are including also the so-called bioplastics, usually obtained from recycling resources. The bioplastics are based on biomaterials as starch, fermentation, and petrochemical products. They constitute an alternative solution to the avoidance of harms induced on environment by using the plastics derived from fossil materials. The optimal uses of bioplastics for biopackaging could be determined by social, economic and environmental criteria. One method allowing the large evaluation of economic and environmental performances of some alternative bioplastics is ELECTRE one (ELimination Et Choix TRaduisant la RealitE), involving multiple criteria to be analyzed. The clear results from the point of view of economic and environmental performances are revealing the bioplastics produced from polyhydroxyalkanoates suitable to be used for packaging manufacturing [19].

The greenest trend in the environment protection commitment is the larger application of green design. In the absence of any incentives (i.e., economic ones) and of any real restraints the development of green design is totally dependent on the moral principles of entrepreneurs. That's why it's adoption is reduced. There are worldwide attempts to establish clear guidelines to govern the relationships between manufacture of products and improvement and protection of environment. Enhancement of social responsibility must represent the basis for green design implementation as a step toward a health environment [20, 21].

## Conclusions

There exist no significant differences between the generated total toxic waste amounts in A (Iasi) and B (Piatra Neamt) studied areas. This lack of differences might be very interesting since we are speaking about two different cities from Moldova region. The lack of significant differences could be explained by almost the same level of income for the residents of the two areas. That means an almost identical lifestyle for the studied areas.

The same time, there exists also no significant difference between the generated packaging waste average quantities in A (Iasi) and B (Piatra Neamt) areas. Although it is clear that there exists a slight difference between the two areas. Interestingly, although the average amount of generated total waste is higher in area A, the average quantity of generated package waste is higher in area B.

The clear result of this study is that the generated packaging waste represents 32.62% as average when

compared to generated total waste in area A (Iasi). Furthermore, for the area B (Piatra Neamt), the generated packaging waste represents 37.15% as average when compared to generated total waste.

When comparing the fractions of generated total waste in the two areas of study the results are really surprisingly. Since it is well known that Piatra Neamt developed the first integrated system of selective collection of household waste, totally functional starting with 2001. When we are comparing the fractions of generated total waste, the results are not significantly different in the two areas. For sure, there are higher rates for selective collection and sorting of paper/cardboard, plastics, glass and organic waste in area B, but not really significant. Such results could be explained solely by the existence of a similar degree of education and commitment regarding the environmental protection in both studied areas.

Moreover, we tried to have an estimation of the costs for local authorities to remove the generated total waste or its selective fractions from the two studied areas. This was a very difficult challenge. For the moment, our conclusions are that for both cities the costs are almost the same, despite the selective sorting and collection of some fractions of generated total waste in area B (Piatra Neamt). The simple conclusion could be that the costs of removal are lower in Iasi city starting from the efficiency of the processes.

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